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PATENT

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY APPLICATION AND APPLICATION FEE TRANSMITTAL (1.53(b))

ASSISTANT COMMISSIONER FOR PATENTS
Box Patent Application
Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of

Named Inventor(s) and
Address(es):

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For:

SPEED CONTROL DEVICE FOR OPTICAL SYSTEM

Enclosed are:

☒ 23 page(s) of specification, 1 page(s) of Abstract, 6 page(s) of claims

☒ 9 sheets of drawing ☒ formal ☐ informal

☐ Page(s) of Declaration and Power of Attorney

☐ Unsigned

☐ Newly Executed

☐ Copy from prior application

☐ Deletion of inventors including Signed Statement under 37 C.F.R. § 1.63(d)(2)

☒ Incorporation by Reference: The entire disclosure of the priority application(s) identified below, is considered as being part of the disclosure of the accompanying application and is incorporated herein by reference.

☐ Microfiche Computer Program (Appendix)

☐ page(s) of Sequence Listing

☐ computer readable disk containing Sequence Listing

☐ Statement under 37 C.F.R. § 1.821(f) that computer and paper copies of the Sequence Listing are the same

☒ Claim for Priority Japanese Application Nos 10-340145 filed 11/30/98 and 11-340146 filed 11/30/98

☐ Certified copy of Priority Document(s)

JC542 U.S. PTO
09/447788

11/23/99

- ☐ English translation documents
- ☐ Information Disclosure Statement
- ☐ Copy of ___Cited references w/ English Abstracts
- ☐ Copy of PTO-1449 filed in parent application serial No. _____
- ☐ Preliminary Amendment
- ☒ Return receipt postcard (MPEP 503)
- ☐ Assignment Papers (assignment cover sheet and assignment documents)
- ☐ A check in the amount of \$40.00 for recording the Assignment.
- ☐ Assignment papers filed in parent application Serial No. _____.
- ☐ Certification of chain of title pursuant to 37 C.F.R. § 3.73(b).
- ☐ This is a ☐ continuation ☐ divisional ☐ continuation-in-part (C-I-P) of prior application serial no. _____.
- ☐ Cancel in this application original claims _____ of the parent application before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)
- ☐ A preliminary Amendment is enclosed. (Claims added by this Amendment have been properly numbered consecutively beginning with the number following the highest numbered original claim in the prior application.
- ☐ The status of the parent application is as follows:
- ☐ A Petition For Extension of Time and a Fee therefor has been or is being filed in the parent application to extend the term for action in the parent application until _____.
- ☐ A copy of the Petition for Extension of Time in the co-pending parent application is attached.
- ☐ No Petition For Extension of Time and Fee therefor are necessary in the co-pending parent application.
- ☐ Please abandon the parent application at a time while the parent application is pending or at a time when the petition for extension of time in that application is granted and while this application is pending has been granted a filing date, so as to make this application co-pending.
- ☐ Transfer the drawing(s) from the patent application to this application.
- ☐ Amend the specification by inserting before the first line the sentence:
This is a ☐ continuation ☐ divisional ☐ continuation-in-part of co-pending application Serial No. _____ filed _____.

I. CALCULATION OF APPLICATION FEE (For Other Than A Small Entity)

					Basic Fee
	Number Filed		Number Extra	Rate	\$ 760.00
Total Claims	21	-20=	1	x\$18.00	\$ 18.00
Independent Claims	6	- 3=	3	x78.00	\$ 234.00
Multiple Dependent Claims					
	[] yes		Additional Fee =	\$260.00	\$ 0
	[X] no		Add'l Fee =	NONE	

Total: \$1,012.00

[] A statement claiming small entity status is attached or has been filed in the above-identified parent application and its benefit under 37 C.F.R. § 1.28(a) is hereby claimed. Reduced fees under 37 C.F.R. § 1.9(F) (50% of total) paid herewith \$ _____.

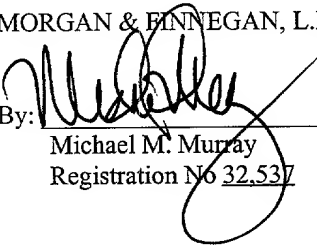
[X] A check in the amount of \$1,012.00 for payment of the application filing fees is attached.

[] Charge Fee(s) to Deposit Account No. 13-4500. Order No. _____. A DUPLICATE COPY OF THIS SHEET IS ATTACHED.

[X] The Assistant Commissioner is hereby authorized to charge any additional fees which may be required for filing this application, or credit any overpayment to Deposit Account No. 13-4500, Order No. 1232-4600. A DUPLICATE COPY OF THIS SHEET IS ATTACHED.

Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Noboru Suzuki
Serial No. : To Be Assigned Examiner: To Be Assigned
Filed : November 23, 1999 (Herewith) Group Art Unit: TBA
For : SPEED CONTROL DEVICE FOR OPTICAL SYSTEM

EXPRESS MAIL CERTIFICATE

Express Mail Label No. EJ606949130US

Date of Deposit November 23, 1999

I hereby certify that the following attached paper(s) and/or fee
Application Fee Transmittal (in duplicate); 23 pp. of specs., 1 page of abstract, 6 pp. claims (21 TOTAL
claims); 9 Sheets of Formal Drawings (Figs. 1-13); check in the amount of \$1,012.00; and return receipt
postcard

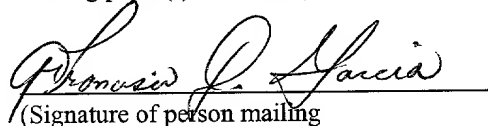
is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37

C.F.R. §1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Box New

Applications, Washington, D.C. 20231.

Francisco J. Garcia

Typed or printed name of person
mailing paper(s) and/or fee)



(Signature of person mailing
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SPEED CONTROL DEVICE FOR OPTICAL SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to an optical unit such as an image sensing lens used in television image sensing.

Related Background Art

10 A conventional broadcasting television camera system performs communication using an analog signal via a camera-lens interface. For example, voltages for determining the position of a focus lens or iris and the speed of a zoom lens are designated for a lens to control a lens system. Voltages representing the
15 positions of a focus lens, zoom lens, and iris are applied to the camera side to transmit the lens information to the camera.

20 A lens uses an analog servo control system by constructing a feedback system using a potentiometer as a position sensor.

 The types, number, and precision of analog signals are limited, and a serial interface tends to be used as a camera-lens communication function.

25 In the above control device, no normalization is performed in transmitting a data, such as the speed data, between the camera and lens, resulting in poor controllability.

SUMMARY OF THE INVENTION

One aspect of the application is to provide an optical apparatus having a drive circuit for receiving speed data communicated from a unit which sends the speed data representing speed information and controlling, on the basis of the information, the speed of a moving member which moves within a predetermined range, comprising a determination circuit for determining a driving speed on the basis of position data, the speed data, and a value representing an actual range of the predetermined range, the position data defining the predetermined range as a predetermined number different from a value indicating the actual range and representing the predetermined number as another value in accordance with a time required to move the moving member within the predetermined range so as to provide an appropriate driving speed.

One aspect of the application is to provide an optical apparatus having a drive circuit for receiving speed data communicated from a unit which sends the speed data representing speed information and controlling, on the basis of the information, the speed of a moving member which moves within a predetermined range, comprising a determination circuit for determining a driving speed on the basis of position data and the speed data, the position data representing

the predetermined range as a predetermined number and the number as another value in accordance with a time required to move the moving member within the predetermined range so as to provide an appropriate driving speed.

One aspect of the application is to provide an optical unit having a moving member moving within a predetermined range and a drive circuit for controlling a speed of the moving member, wherein the speed of the moving member is determined on the basis of position data representing the predetermined range as a predetermined number of steps and speed data representing a moving amount per unit time as the predetermined number of steps.

The above and other objects, features, and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment in conjunction with the accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the system configuration of the first embodiment of the present invention;

Fig. 2 is a block diagram showing an encoder pulse output mechanism in Fig. 1;

Fig. 3 is a view for explaining the output pulse

number of an encoder in Fig. 1;

Fig. 4 is a view for explaining the number of normalization steps in the first embodiment;

Fig. 5 is a view showing the lens moving direction of the first embodiment;

Fig. 6 is a pulse number table 1 of the first embodiment;

Fig. 7 is a pulse number table 2 of the first embodiment;

Figs. 8A and 8B are waveform charts in the CW and CCW directions, respectively;

Fig. 9 is a normalized speed command table of the first embodiment;

Fig. 10 is another normalized speed command table of the first embodiment;

Fig. 11 is still another normalized speed command table of the first embodiment;

Fig. 12 is a table representing the whole range movement time with respect to the normalized speed command of the first embodiment; and

Fig. 13 is a view for explaining the normalized positions and speed commands of the first embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

(First Embodiment)

Fig. 1 is a block diagram showing an optical system according to the first embodiment of the present

invention. The optical system comprises a lens unit 101 for image sensing and camera unit 121 for sensing an image through the lens unit 101.

5 A controller (to be referred to as an aCPU hereinafter) 102 manages the lens unit and controls the servo system. A driver 103 drives a motor 104. An optical lens 106 is connected to the motor 104. An encoder 107 detects the position of the optical lens 106 and outputs the pulse number corresponding to the moving amount of the lens. A counter 108 counts outputs (pulses) from the encoder 107.

10 A timer 112 and the counter 108 are connected to the aCPU 102. The aCPU 102 uses the values of the counter 108 and timer 112 to detect the position and speed of the optical lens 106.

15 A manual operation portion 105 manually operates the optical lens 106. A switch (to be referred to as an R/L-SW hereinafter) 110 selects control of the lens unit 101 in the remote or local mode. A demand 131 is connected to an A/D converter 111 in the lens unit 101. The A/D converter 111 A/D-converts a command from the demand 131. A demand command value for controlling the optical lens 106 can be input to the aCPU 102.

20 A camera controller (to be referred to as a bCPU hereinafter) 122 is mounted in the camera unit 121 and performs serial communication 141 with the aCPU 102 of the lens unit 101.

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The remote and local modes selectively set by the R/L-SW 110 will be described below. The remote mode is to control the optical lens 106 in accordance with a control command from the bCPU 122 in the camera unit 121. The local mode is to control the optical lens 106 by selecting a control command from the demand 131.

The relationship between the moving direction of the optical lens 106 and the count value of the counter 108 will be described with reference to Fig. 5. Assume that the optical lens 106 is a focus lens.

If the count value of the counter 108 at the infinity (INF) end 210 of the focus lens is defined as 0, the count value of the counter 108 at the minimum object distance (MOD) end 211 is 20,000.

When the focus lens rotates in the clockwise (CW) direction, the focus lens moves to the MOD end 211 direction to increment the counter 108. When the focus lens rotates in the counterclockwise (CCW) direction, the focus lens moves to the INF end 210 direction to decrement the counter 108.

During which the focus lens is moving in the MOD end 211 direction, the speed of the focus lens takes a positive value. During which the focus lens is moving in the INF end 210 direction, the speed of the focus lens takes a negative value.

The encoder pulse output mechanism for detecting the position and speed of the focus lens will be

described with reference to Fig. 2.

The diameter of a C gear 202 mounted on the drive motor 104 is ϕ_{Motor} [mm], and the diameter of a B gear 203 meshed with the C gear 202 is ϕ_{Focus} [mm]. A focus lens 207 can move from the INF end (infinity) 210 to the MOD (minimum object distance) end 211 by B gear 203.

The B gear 203 is meshed with an A gear 204 mounted on the encoder 107, and a pulse output from the encoder 107 is input to the counter 108. The diameter of the A gear 204 is ϕ_{Enc} [mm], and the output pulse per rotation of the encoder 107 is PPEnc [P/R]. The focus lens 207 can be moved from the INF end 210 to the MOD end 211 by using the manual operation portion 105.

A servo/manual mode selection SW (not shown) is arranged. In the servo mode, the focus lens 207 is driven by the motor 104. In the manual mode, the focus lens 207 can be operated by using the manual operation portion 105.

A clutch (not shown) is connected to the motor 104. In the manual mode, the encoder 107 rotates in accordance with movement of the focus lens 207. However, the driving force of the motor 104 is not transmitted to the focus lens 207 by the clutch.

In the above arrangement, the counter 108 represents the following count value PPRot per rotation of the motor 104:

$$PPRot = \phi_{Motor} / \phi_{Enc} \times PPEnc \quad \dots(1)$$

If the rotation number of the motor 104 for moving the focus lens 207 from the INF end 210 to the MOD end 211 is defined as NRot, an output pulse number PPTotal of the encoder 107, which is generated when the focus lens 207 moves from the INF end 210 to the MOD end 211, is given as follows:

$$PPTotal = PPRot \times NRot \quad \dots(2)$$

The count of the counter 108 which counts the output pulses from the encoder 107 upon moving the focus lens 207 from the INF end 210 to the MOD end 211 is calculated using equations (1) and (2) under the following conditions.

[Conditions]

Output Pulse Number per Rotation of Encoder 107

$$PPEnc = 2500 \text{ [P/R]}$$

Diameter of A Gear Mounted on Encoder 107

$$\phi_{Enc} = 10 \text{ [mm]}$$

Diameter of C Gear Mounted on Motor 104

$$\phi_{Motor} = 20 \text{ [mm]}$$

Rotation Number of Motor 104 for Moving Focus Lens 207 from INF End 210 to MOD End 211

$$100 \text{ [rotations]}$$

At this time, when the count value of the counter 108 at the INF end 210 is set to "0", the count value PPTotal of the counter 108 at the MOD end 211 is given as follows:

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and the output pulse number PPEnc per rotation of the encoder 107. The count value PPTotal has a considerably wide range.

5 The pattern of the count value of the counter 108 at the MOD end 211, as shown in Fig. 3, when the INF end 210 is defined as a reference value "0" (count value of the counter 108) for the focus lens 207 will be described below.

10 For example, when the count values of the counter 108 at the MOD end 211 are given as 10,000, 500,000, and 35,000,000, the numbers of bytes required for these count values are given as follows:

- (1) 2 bytes for 10,000 [pulses]
- (2) 3 bytes for 500,000 [pulses]
- 15 (3) 4 bytes for 35,000,000 [pulses]

This indicates that data changes depending on the types of lens units 101 when the bCPU 122 of the camera unit 121 designates the position of the focus lens 207 using serial communication 141. For example, when the
20 bCPU 122 designates via the serial communication 141 that the focus lens 207 is moved to a position of 5,000, the aCPU 102 of the lens unit 101 moves the lens unit 101 as follows:

5000/10000 = 0.5 (= 50 [%]) for (1); the focus
25 lens 207 is moved to the center between the INF end 210 and MOD end 211.

5000/500000 = 0.01 (= 1 [%]) for (2); the focus

lens 207 is moved to a position near the INF end 210.

$5000/35000000 \approx 0.00014$ (= 0.014 [%]) for (3); the focus lens 207 is rarely moved from the INF end 210.

As can be apparent from the above result, the bCPU
5 122 of the camera unit 121 must know the resolution
(pulse number of the whole movable range from the INF
end 210 to the MOD end 211) of the effective movable
range of the focus lens 207 of the lens unit 101. The
bCPU 122 obtains the resolution by information exchange
10 via the serial communication 141 when initialization of
the camera unit 121 and lens unit 101 is complete. A
description will be made for, e.g., (2). When the bCPU
122 of the camera unit 121 requests position resolution
information of the focus lens 101 to the aCPU 102 of
15 the lens unit 101 via the serial communication 141, the
aCPU 102 transfers the positions of the INF end 210 and
MOD end 211 as "0" and "500,000", respectively, to the
bCPU 122 of the camera unit 121 via the serial
communication 141.

20 As can be apparent from (1) to (3), the numbers of
bytes of position information of the focus lens 207 are
different from each other. This indicates that the
data length necessary for arithmetic operation of the
bCPU 122 of the camera unit 121 changes depending on
25 the types of lens units 101.

Assume that the bCPU 122 of the camera unit 121 is
a 16-bit microcomputer. In this case, arithmetic

processing for (1) can be performed with a 2-byte (16
bits, int) length. Arithmetic processing for (2)
requires a 4-byte (32 bits, long) length. Arithmetic
processing for (3) must be performed with the floating
5 point (float). Arithmetic processing often requires
high speed, processing must be performed with the fixed
decimal point as much as possible. Arithmetic
processing is desirably possible with int (16-bit data
length for a 16-bit microcomputer; 32-bit data length
10 for a 32-bit microcomputer).

As shown in Fig. 4, the resolutions between the
INF end 210 and MOD end 211 are normalized, and fixed
data is always used to give a position command between
the lens unit 101 and camera unit 121 via the serial
15 communication 141.

This makes it possible for the camera unit 121 not
to consider the resolution of the focus lens 207
depending on the types of lens units 101.

The position resolution required for the focus
20 lens 207 will be described below. The resolution
calculated by the MTF and sensitivity is said to be
about 1/5000 for NTSC and about 1/20,000 for HD.

Assume that the whole range, INF end 210, and MOD
end 211 are given by 30,000, "0", and "30,000",
25 respectively. A sufficient resolution can be obtained
for the focus lens 207.

When the position command for the focus lens 207

is given as "15,000", the aCPU 102 of the lens unit 101 moves the focus lens 207 to positions having the following ratios using the above normalized data:

- (10000 × 15000 / 30000) / 10000 = 0.5 for (1)
5 (500000 × 15000 / 30000) / 500000 = 0.5 for (2)
(35000000 × 15000 / 30000) / 35000000 = 0.5 for
(3)

The aCPU 102 can move the focus lens 207 to the middle position between the INF end 210 and MOD end 211 regardless of the types of lens units 101 (pulse number
10 from the INF end 210 to MOD end 211 of the focus lens 207).

The normalized position information may be exchanged using the serial communication 141 after
15 initialization of the lens unit 101 and camera unit 121 is complete. Alternatively, the normalized position information may be predetermined by information communication format between the lens unit 101 and camera unit 121.

20 The following equation is used to calculate a command position PPFocus Cmd of the focus lens 207 in the lens unit 101 in accordance with the normalized position command:

$$\text{PPFocus Cmd} = \text{PPInfMod} \times \text{NorFocus Cmd} / \text{NorInfMod} \quad \dots(3)$$

25

where NorInfMod is the whole range normalized position between the INF and MOD ends, PPInfMod is the

The following equation is used to obtain the normalized position information NorFocusInf from the current position PPFocusInf of the focus lens 207:

$$\text{NorFocusInf} = \text{NorInfMod} \times \text{PPFocusInf} / \text{PPInfMod} \quad \dots(4)$$

A speed command will be described with reference
to Fig. 9. A system is generally incorporated in a
video camera using a signal synchronized with image
data for performing image processing. In this case, a
vertical synchronizing signal (V synchronizing signal)
as one frame of an image signal is used.

The whole range normalized position, i.e.,
normalized step number of movable range for lens, for

speed is given as "30,000". The absolute value of the speed command of the minimum unit is "one step/V synchronizing unit". The next speed is "two steps/V synchronizing unit". At this time, a change in minimum speed is "± one step/V synchronizing unit". If the current speed command is given as "N steps/V synchronizing unit", the minimum speed command changing ratio is $(1/N) \times 100$ [%]. The table of this result is shown in Fig. 9.

As can be apparent from this table, when the speed command of the V synchronizing unit falls within the range of about 1 to 10, the speed changing ratio is considerably large. When the speed command is about 25 or more, the changing ratio falls within the range of 5 [%] or less.

When the speed command becomes about 1,600, the speed changing ratio rarely changes (the changing ratio is small). Values required as speeds of TV lenses generally fall within the whole range movement time range of 0.3 [sec] to 300 [sec], and have a value 1,000 times as the dynamic range. The whole range movement time can be calculated by the following equation:

$$\begin{aligned} &(\text{Whole Range Movement Time [sec]}) = (\text{Whole Range} \\ &\text{Normalized Position for Speed}) / (\text{Normalized Speed} \\ &\text{Command (Step Number)}) \times (\text{V Synchronizing Unit}) \\ &[\text{sec}] \end{aligned} \quad \dots(5)$$

As described above, the speed is defined using the

whole range normalized position for speed (range information defining the movable range as the predetermined range regardless of the actual movable range). Even if a lens having another movable range is mounted on a camera, processing can be performed using the whole range movement time as a constant time if a speed command from the camera is kept unchanged.

As described above, processing can be performed using the whole range movement time as the constant value when the speed command is kept unchanged. When the minimum unit of the speed command changes, a large speed command value has a speed changing ratio different from that of a small speed command value.

More specifically, in control using equation (5), a sufficient speed resolution is obtained on the high speed movement side (the speed command resolution is 0.06 [%] in the whole range movement time of about 5 [sec]). The practical range on the low speed movement side has the whole range movement time of about 20 sec (speed resolution of about 4 [%]). That is, a changing ratio becomes 50 [%] in the whole range movement time of 250 [sec]. The changing ratio is too large in the practical range. The practical use limits the speed changing ratio of 5 [%] or less because the speed changing ratio exceeding this range is too large to use.

Fig. 10 shows a case in which the whole range

normalized position for speed is set to "500,000". In this case, the speed command becomes about 25 [steps/V synchronizing unit] near the whole range movement time of about 300 [sec]. Therefore, the speed changing ratio can fall within the range of 5 [%] or less.

Since the speed command on the high speed movement side (whole range movement time of 0.3 [sec]) is 27,400 [steps/V synchronizing unit] or less, the corresponding speed command falls within the 16-bit range from the high speed to the low speed.

When the whole range normalized position for speed is set to "500,000", the speed changing ratio on the high speed movement side is very small, and a command for commanding high speed movement is hard to process. The list of speed commands for the whole range normalized position of "1000" for high speed movement is shown in Fig. 11. As can be apparent from this table, the speed changing ratio on the high speed movement (whole range movement time of 0.5 [sec] or less) side is about 2 to 3 [%], and the high speed movement speed commands can be easily processed.

Similarly, it is possible to obtain a whole range normalized position for middle speeds.

Differences occurring when the same normalized speed command is given to high, middle, and low speed movement speed commands will be described with reference to Fig. 12.

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The whole range movement times are calculated under the assumptions that the high, middle, and low speed movement speed commands take "1,000", "30,000", and "500,000" as whole range normalized positions, respectively. Since a speed changing ratio that facilitates speed operation when applying a speed command is considered to be about 2 [%], the normalized speed command is defined as 50 [steps/V synchronizing unit = 1/60 [sec]] corresponding to the speed changing ratio of 2 [%].

The whole range movement times for the high, middle, and low speed movement speed commands are 0.33 [sec], 10.00 [sec], and 166.67 [sec], respectively. That is, the lens can be driven selecting a high, middle, and low speed movement speed command in consideration of the speed changing ratio at which easy operation is allowed. A speed command is given in consideration of the speed resolution, thereby allowing smooth lens control.

The format of the command will be described with reference to Fig. 13. As a scheme for sending a command from the camera unit 121 to the lens unit 101, a format made up of an 8-bit head portion and 16-bit data portion is employed.

In this case, the head portion is assigned for a movement command of lens 106 and the data portion is assigned for a command information. For example, the

movement command A1H is defined as a normalized position command. In this case, B1H (corresponding to 500,000 described above and representing low speed movement whole range normalized position), B2H (corresponding to 30,000 described above and representing middle speed movement whole range normalized position), and B3H (corresponding to 1000 described above and representing the high speed movement whole range normalized position) are assigned to low, middle, and high speed whole range normalized speed commands, respectively.

The data portion is assigned for the normalized position command which contains position information representing a position at which the lens 106 is to be stopped.

The data portion in case of the normalized speed command contains a value determined in consideration of the direction of the movement step number of the V synchronizing unit. In this case, the direction takes a positive (+) value when the focus lens 207 is moved toward the MOD end 211 and a negative (-) value when the lens 207 is moved toward the INF end 210.

The normalized speed command can take values falling within the range of "-2,000 [steps/V synchronizing unit]" to "+2,000 [steps/V synchronizing unit]" at the speed command whole range normalized position of 30,000 and the maximum speed data of the

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per step is 1/60 sec, the driving speed is represented by equation $X / 1000 \times 60 \times 50$.

The speed of the lens drive (motor) is defined as $X / [\text{whole range normalized position}] \times [\text{normalized speed command}] \times [\text{V synchronizing unit}]$, in accordance with the above normalized speed command and whole range normalized position. The lens side performs the above calculation in accordance with the whole range normalized position and normalized speed command from the camera unit, thereby determining the motor speed and performing speed control.

The normalized speed command preferably has a value range so that the speed changing ratio falls within the range of 2 to 3%.

A speed command as a command sent from the camera unit 121 to the lens unit 101 has been described with reference to Figs. 9 to 13. Speed information of the lens 106 of the lens unit 101 may be similarly defined as described above and sent to the camera unit 121.

The "V synchronizing unit" has been used as the time-axis unit of the speed command or speed information. However, any other unit may be used.

The focus lens has been described as the lens 106 of the lens unit 101. However, the present invention is also applicable to any other optical system such as a zoom lens or iris.

The present invention is also applicable to an

accessory except the camera unit. The encoder is used as a means for detecting the lens position. However, a combination of a potentiometer and A/D converter may be used. The position command normalized positions and speed command normalized positions are exemplified by values "30,000", "50,000", and "1,000". The values are not limited to these specific values, but can be replaced with other values. Serial communication is used in communication between the lens unit and camera unit. However, parallel communication can be used.

Communication using the position command normalized position and speed command normalized position is not limited to one between the lens unit 101 and camera unit 121. A command from the demand 131 serving as an accessory is input to the aCPU 102 of the lens unit 101 via the A/D converter 111. However, when a CPU is mounted in the demand 131 and has the same communication function as in the camera unit, it is possible to apply the above communication by normalizing the lens position and speed.

Communication upon normalizing the position and speed information of the lens 106 is also applicable to communication between the lens unit 101 and another system (including an accessory) like the camera unit 121.

As has been described above, according to the present invention, for example, in a combination of an

image sensing lens and a camera or accessory, or in an
image sensing lens itself, the speed of a moving member
such as an optical system can be controlled using
predetermined arithmetic processing regardless of the
5 types of systems for driving lens systems.

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WHAT IS CLAIMED IS:

1. An optical apparatus having a drive circuit
for receiving speed data communicated from a unit which
sends the speed data representing speed information and
controlling, on the basis of the information, the speed
of a moving member which moves within a predetermined
range, comprising

a determination circuit which determines a driving
speed on the basis of position data, the speed data,
and a value representing an actual range of the
predetermined range, the position data defining the
predetermined range as a predetermined number different
from a value indicating the actual range and
representing the predetermined number as another value
in accordance with a time required to move the moving
member within the predetermined range wherein, the
drive circuit drives the moving member at the driving
speed determined by said determination circuit.

2. An apparatus according to claim 1, wherein
said determination circuit determines the speed in
accordance with a ratio of the value representing the
actual range and the position data, and a value
obtained by multiplying the speed data with the ratio.

25

3. An optical apparatus having a drive circuit
for receiving speed data communicated from a unit which

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sends the speed data representing speed information and controlling, on the basis of the information, the speed of a moving member which moves within a predetermined range, comprising

5 a determination circuit which determines a driving speed on the basis of the speed data and position data representing the predetermined range as a predetermined number; and

10 a changing circuit which changes the number of position data representing the predetermined range as the predetermined number, in accordance with time information required to move the moving member within the predetermined range, wherein the drive circuit drives the moving member at a speed determined by said
15 determination circuit.

4. An optical apparatus having a drive circuit for receiving speed data communicated from a unit which sends the speed data representing speed information and
20 controlling, on the basis of the information, the speed of a moving member which moves within a predetermined range, comprising

25 a determination circuit which determines a driving speed on the basis of position data and the speed data, the position data representing the predetermined range as a predetermined number and the number as another value in accordance with a time for moving the moving

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member within the predetermined range, wherein the drive circuit drives the moving member at a speed determined by said determination circuit.

5 5. An apparatus according to claim 4, wherein the speed data represents a moving amount per unit time as a step number.

10 6. An apparatus according to claim 5, wherein the position data represents the predetermined range as a step number.

15 7. An apparatus according to claim 4, wherein said determination circuit determines the speed in accordance with a ratio of the speed data and position data.

20 8. An optical unit having a moving member moving within a predetermined range and a drive circuit for controlling a speed of the moving member, comprising
a determination circuit which determines a speed of the moving member on the basis of position data representing the predetermined range as a predetermined step number and speed data representing a moving amount
25 per unit time as the step number,

wherein the step number of the position data representing the predetermined range is changed in

accordance with a speed control state.

9. A unit according to claim 8, wherein the step
number of the position data is changed in accordance
5 with time information required to move the moving
member within the predetermined range.

10. A unit according to claim 8, wherein the step
number of the position data is so changed as to make a
10 changing ratio of the speed of the moving member fall
within a predetermined range with respect to a minimum
change in speed data.

11. A unit according to claim 10, wherein the step
15 number of the position data is changed in accordance
with time information required to move the moving
member within the predetermined range.

12. A unit according to claim 8, wherein said
20 determination circuit determines the speed in
accordance with a ratio of speed data and position
data.

13. An optical unit having a moving member moving
25 within a predetermined range and a drive circuit for
controlling a speed of the moving member, comprising:
a speed control circuit which determines a speed

of the moving member on the basis of position data representing the predetermined range as a predetermined step number and speed data representing a moving amount per unit time as the step number; and

5 a communication unit which communicates the position data from an apparatus connected to said optical unit to said optical unit.

10 14. A unit according to claim 13, wherein the step number of the position data changes in accordance with time information required to move the moving member within the predetermined range.

15 15. A unit according to claim 14, wherein the step number of the position data is so set as to fall a changing ratio of the speed of the moving member within a predetermined range with respect to a minimum change in speed data.

20 16. A unit according to claim 13, wherein said speed control circuit determines the speed in accordance with a ratio of speed data and position data.

25 17. A unit according to claim 13, wherein the speed data is communicated from the apparatus.

18. A unit according to claim 13, wherein said optical unit comprises a lens unit, and the apparatus comprises a camera.

5 19. An optical unit having a moving member moving within a predetermined range and a drive circuit for controlling a speed of the moving member, comprising
a determination circuit which determines a speed
of the moving member on the basis of position data
10 representing the predetermined range as a predetermined step number and speed data representing a moving amount per unit time as the step number,

wherein the drive circuit drives the moving member at a speed determined by said determination circuit.

15 20. A unit according to claim 19, wherein the speed data is communicated from an apparatus connected to said optical unit.

20 21. A unit according to claim 20, wherein said optical unit comprises a lens unit, and the apparatus comprises a camera.

ABSTRACT OF THE DISCLOSURE

This invention relates to a system for communicating speed data from a camera to a lens unit to drive the lens unit. Even if speed data changes
5 stepwise, a change amount of the driving speed can be changed within a predetermined range for each stepwise change of the speed data in a whole driving speed change range. An optical apparatus having drive
10 circuit for receiving speed data communicated from the unit which sends the speed data representing speed information and controlling, on the basis of the information, the speed of a moving member which moves within a predetermined range includes a determination
15 circuit for determining a driving speed on the basis of position data, the speed data, and a value representing an actual range of the predetermined range, the position data defining the predetermined range as a predetermined number different from a value indicating the actual range and representing the predetermined
20 number as another value in accordance with a time required to move the moving member within the predetermined range.

FIG. 1

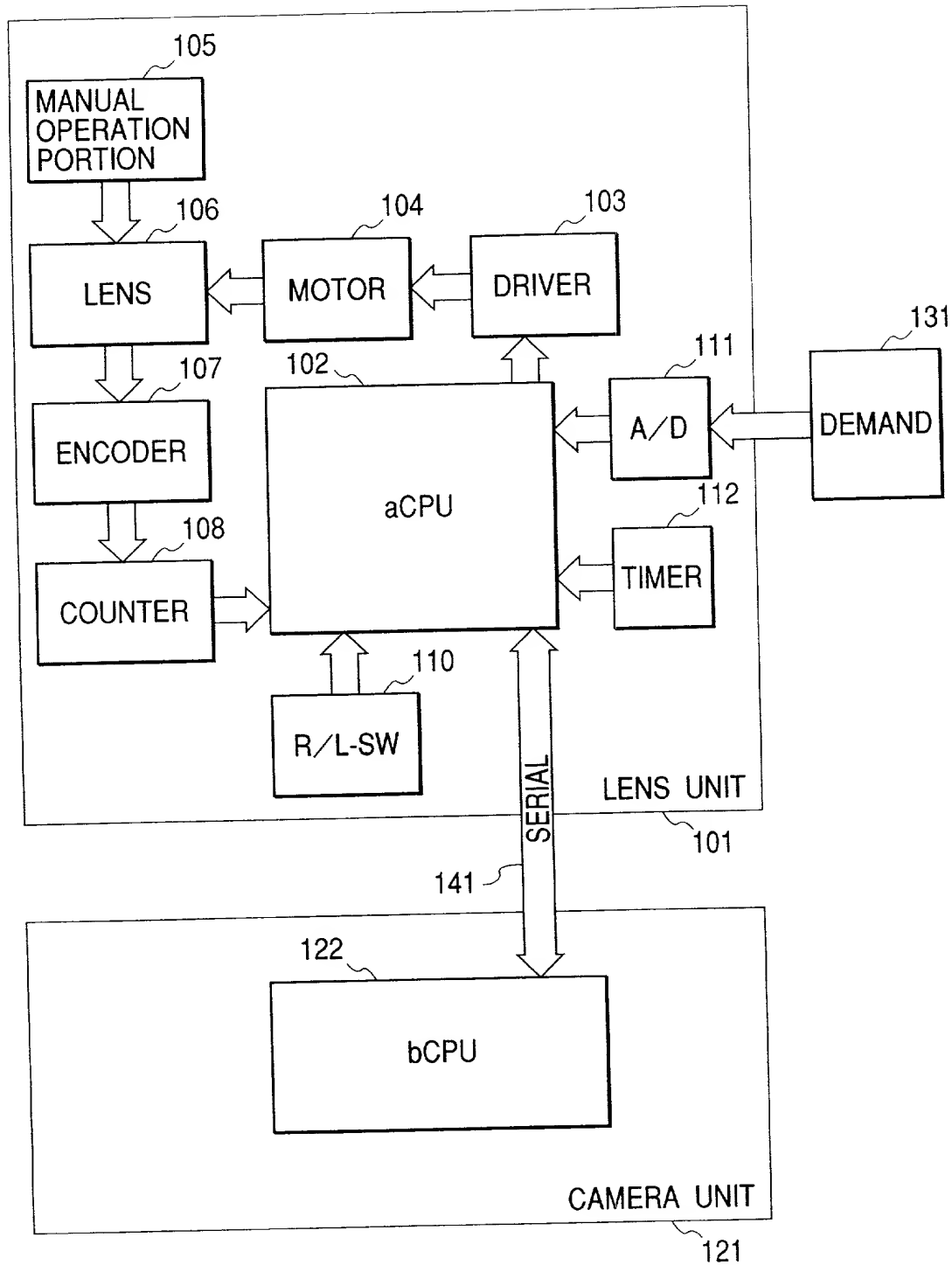


FIG. 2

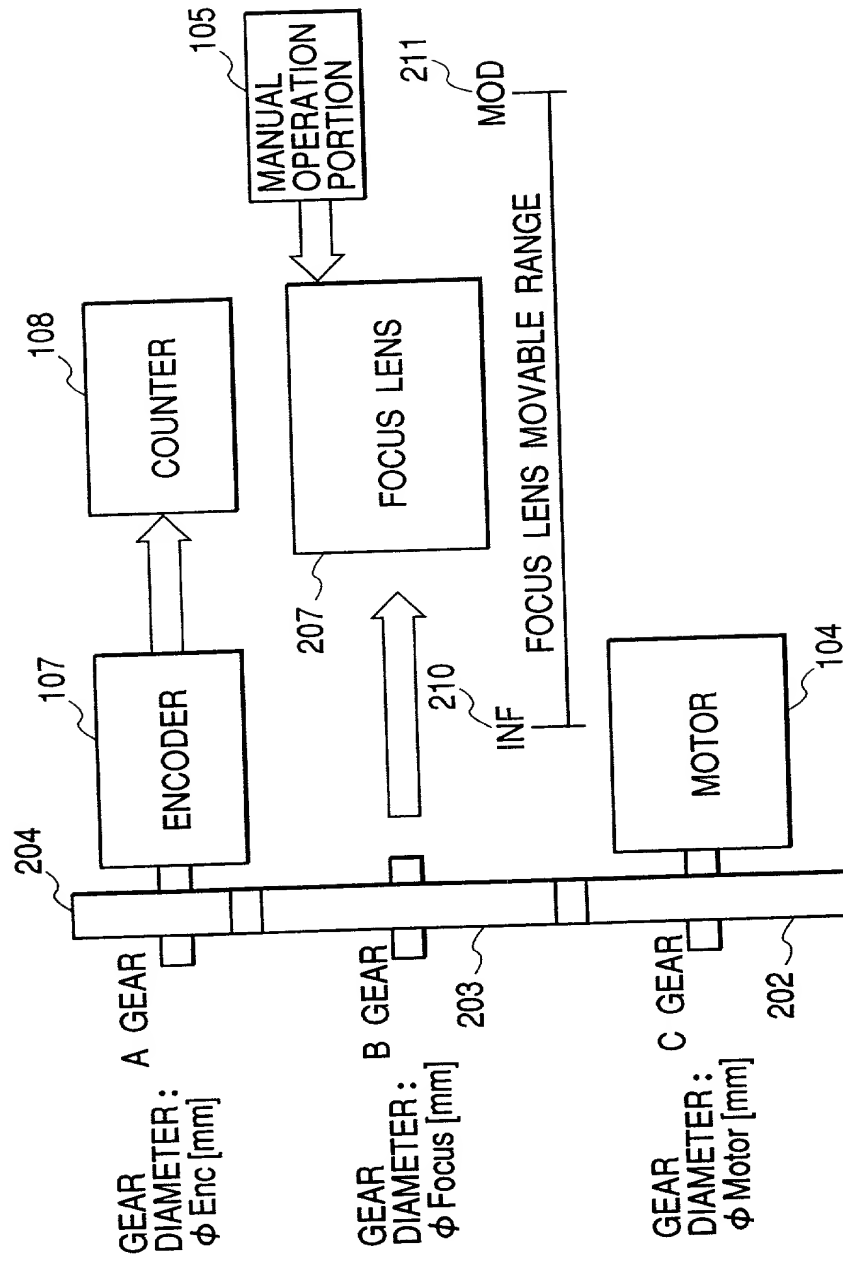


FIG. 3

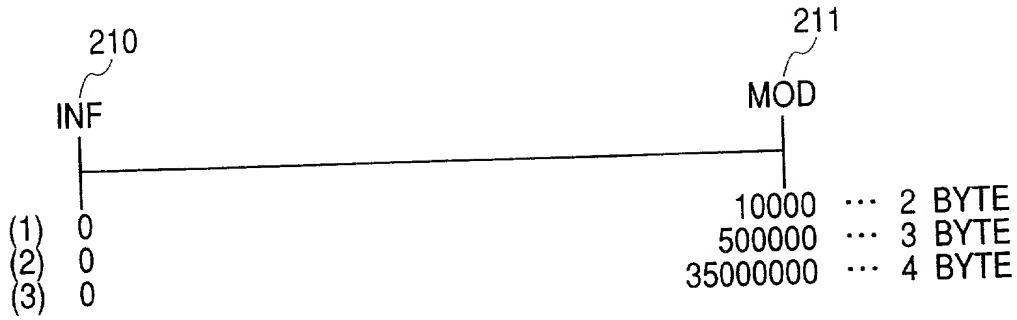


FIG. 4

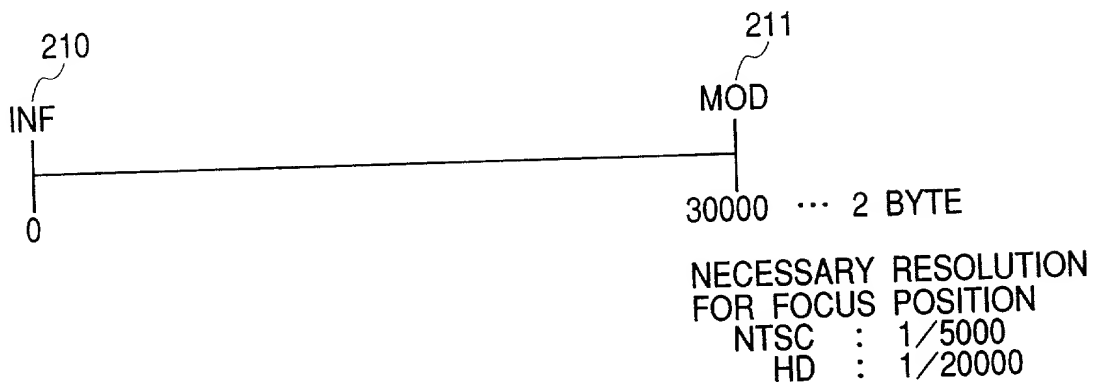


FIG. 5

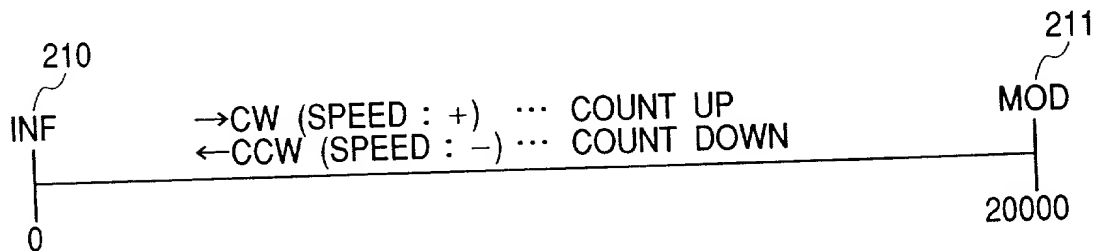


FIG. 6

OUTPUT PULSE NUMBER PER ONE ROTATION OF ENCODER 2500		PPEnc [P/R]	
MOTOR GEAR DIAMETER ϕ Motor [mm]	ENCODER GEAR DIAMETER ϕ Enc [mm]	COUNTER PULSE NUMBER PPTotal [pulse]	
		MOTOR ROTATION NUMBER FROM INF TO MOD	
		NRot=20	NRot=100
20	20	50000	250000
20	10	100000	500000
5	20	12500	62500

FIG. 7

OUTPUT PULSE NUMBER PER ONE ROTATION OF ENCODER 2500		PPEnc [P/R]	
MOTOR GEAR DIAMETER ϕ Motor [mm]	ENCODER GEAR DIAMETER ϕ Enc [mm]	COUNTER PULSE NUMBER PPTotal [pulse]	
		MOTOR ROTATION NUMBER FROM INF TO MOD	
		NRot=20	NRot=100
20	20	200000	1000000
20	10	400000	2000000
5	20	50000	250000

FIG. 8A

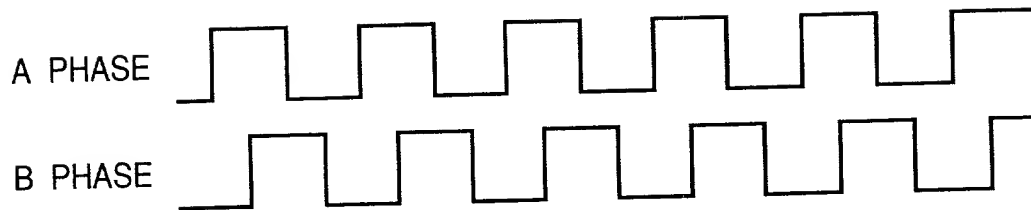


FIG. 8B

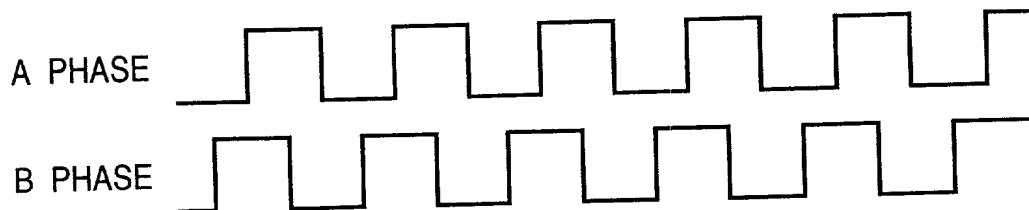


FIG. 9

WHOLE RANGE NORMALIZED POSITION : 30000

SPEED COMMAND V SYNCHRONIZING UNIT	SPEED COMMAND CHANGING RATIO [%]	WHOLE RANGE MOVEMENT TIME [sec.]
1	100.00	500.00
2	50.00	250.00
3	33.33	166.67
4	25.00	125.00
5	20.00	100.00
6	16.67	83.33
7	14.29	71.43
8	12.50	62.50
9	11.11	55.56
10	10.00	50.00
⋮	⋮	⋮
25	4.00	20.00
26	3.85	19.23
27	3.70	18.52
28	3.57	17.86
29	3.45	17.24
30	3.33	16.67
31	3.23	16.13
32	3.13	15.63
33	3.03	15.15
34	2.94	14.71
⋮	⋮	⋮
1635	0.061	0.306
1636	0.061	0.306
1637	0.061	0.305
1638	0.061	0.305
1639	0.061	0.305
1640	0.061	0.305
1641	0.061	0.305
1642	0.061	0.305
1643	0.061	0.304
1644	0.061	0.304

SPEED COMMAND
CHANGING RATIO
IS CONSIDERABLY
LARGE

SPEED COMMAND
CHANGING RATIO
IS WITHIN 5%

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FIG. 10

		WHOLE RANGE MOVEMENT TIME [sec.]	
SPEED COMMAND V SYNCHRONIZING UNIT	SPEED COMMAND CHANGING RATIO [%]	WHOLE RANGE NORMALIZED PORTION 30000	WHOLE RANGE NORMALIZED PORTION 500000
1	100.00	500.00	8333.33
2	50.00	250.00	4166.67
3	33.33	166.67	2777.78
4	25.00	125.00	2083.33
5	20.00	100.00	1666.67
6	16.67	83.33	1388.89
7	14.29	71.43	1190.48
8	12.50	62.50	1041.67
9	11.11	55.56	925.93
10	10.00	50.00	833.33
⋮	⋮	⋮	⋮
25	4.00	20.00	333.33
26	3.85	19.23	320.51
27	3.70	18.52	308.64
28	3.57	17.86	297.62
29	3.45	17.24	287.36
30	3.33	16.67	277.78
31	3.23	16.13	268.82
32	3.13	15.63	260.42
33	3.03	15.15	252.53
34	2.94	14.71	245.10
⋮	⋮	⋮	⋮
1635	0.061	0.306	5.097
1636	0.061	0.306	5.094
1637	0.061	0.305	5.091
1638	0.061	0.305	5.088
1639	0.061	0.305	5.084
1640	0.061	0.305	5.081
1641	0.061	0.305	5.078
1642	0.061	0.305	5.075
1643	0.061	0.304	5.072
1644	0.061	0.304	5.069
⋮	⋮	⋮	⋮
27365	0.004	0.018	0.305
27366	0.004	0.018	0.305
27367	0.004	0.018	0.305
27368	0.004	0.018	0.304
27369	0.004	0.018	0.304
27370	0.004	0.018	0.304

SPEED
COMMAND
CHANGING
RATIO IS
CONSIDERABLY
LARGE

SPEED
COMMAND
CHANGING
RATIO IS
WITHIN 5%

SPEED
COMMAND
CHANGING
RATIO IS
SUBSTANTIALLY
EQUAL TO 0%

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FIG. 11

		WHOLE RANGE MOVEMENT TIME [sec.]	
SPEED COMMAND V SYNCHRONIZING UNIT	SPEED COMMAND CHANGING RATIO [%]	WHOLE RANGE NORMALIZED PORTION 1000	WHOLE RANGE NORMALIZED PORTION 500000
1	100.00	16.67	8333.33
2	50.00	8.33	4166.67
3	33.33	5.56	2777.78
4	25.00	4.17	2083.33
5	20.00	3.33	1666.67
6	16.67	2.78	1388.89
7	14.29	2.38	1190.48
8	12.50	2.08	1041.67
9	11.11	1.85	925.93
10	10.00	1.67	833.33
⋮	⋮	⋮	⋮
33	3.03	0.505	252.53
34	2.94	0.490	245.10
35	2.86	0.476	238.10
36	2.78	0.463	231.48
37	2.70	0.450	225.23
38	2.63	0.439	219.30
39	2.56	0.427	213.68
40	2.50	0.417	208.33
41	2.44	0.407	203.25
42	2.38	0.397	198.41
43	2.33	0.388	193.80
44	2.27	0.379	189.39
45	2.22	0.370	185.19
46	2.17	0.362	181.16
47	2.13	0.355	177.30
48	2.08	0.347	173.61
49	2.04	0.340	170.07
50	2.00	0.333	166.67
51	1.96	0.327	163.40
52	1.92	0.321	160.26
53	1.89	0.314	157.23
54	1.85	0.309	154.32
55	1.82	0.303	151.52
56	1.79	0.298	148.81
57	1.75	0.292	146.20
58	1.72	0.287	143.68
59	1.69	0.282	141.24
60	1.67	0.278	138.89

SPEED
COMMAND
CHANGING
RATIO IS
CONSIDERABLY
LARGE

IN CASE THAT
NORMALIZED
POSITION IS
"1000",
SINCE SPEED
COMMAND
CHANGING
RATIO IS
CLOSE TO
"2%", SPEED
COMMAND IS
EASY TO DEAL
WITH

FIG. 12

V SYNCHRONIZING UNIT = 1/60 (sec.)

	NORMALIZED SPEED COMMAND 50 [STEP/V SYNCHRONIZING UNIT]	
	WHOLE RANGE NORMALIZED POSITION FOR SPEED COMMAND	WHOLE RANGE MOVING TIME [sec.]
HIGH SPEED MOVEMENT SPEED COMMAND	1000	0.33
MIDDLE SPEED MOVEMENT SPEED COMMAND	30000	10.00
LOW SPEED MOVEMENT SPEED COMMAND	500000	166.67

FIG. 13